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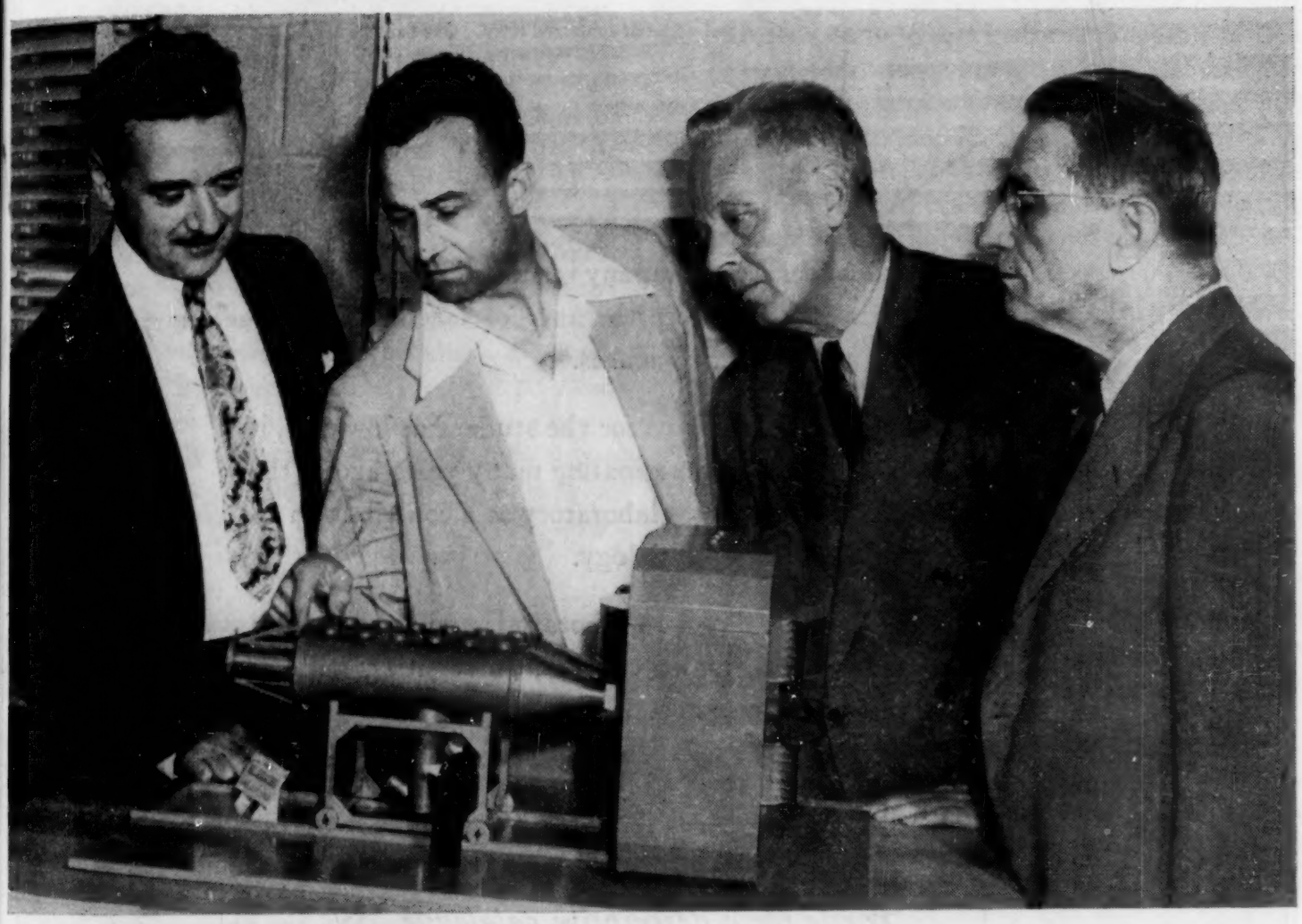

At the ground-breaking ceremonies for the first peacetime atomic pile, held at Brookhaven National Laboratory August 11, Philip M. Morse (*left*), director of the Laboratory, and M. Stanley Livingston (*left center*), head of the Cyclotron Project, are shown with Sumner T. Pike and William W. Waymack, members of the U. S. Atomic Energy Commission, examining a small-scale model of a 60-inch cyclotron to be constructed in the near future.

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Military Psychology in War and Peace

Walter V. Bingham

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Military Psychology in War and Peace

Walter V. Bingham

Personnel Research and Procedures Branch, Adjutant General's Office, War Department, Washington, D. C.

WHAT ARE THE CONTINUING PROBlems of military psychology? This is a timely question. It should be faced squarely, in these chaotic days between war and peace, before the cataclysm of World War II has receded too far into the past. Today it is possible to look closely at the varied kinds of professional work done by psychologists—more than 1,300 strong—who wore the uniforms of the armed forces or were employed by them between 1940 and 1946 (2). We can thrill with pride at their accomplishments, take note of serious discrepancies between need and fulfillment, and undertake to discern those problems of military psychology which undoubtedly will still be pressing a few years hence.

It should not be assumed that the pattern of warfare 5 years hence, or 50, will closely resemble that of World War II. A third World War will differ quite as much from the second as the second did from the first in magnitude and in the terrific destruction of civilian lives, dwellings, and industries. If it comes, it will be greatly depersonalized—relatively less man-to-man combat, we are told—and there will surely be increasing reliance on highly intricate mechanisms. Any future war, then, is likely to differ greatly from those of the past in scope, intensity, speed, civilian involvement, depersonalization, and mechanization.

In some respects, however, the pattern is bound to be a familiar one. Consider the practical certainty that an undeclared aggression, a surprise attack, will usher in any future war. Then recall the vast array of military activities which are rooted in basic facts of psychology—facts as to the limits of human capabilities, the modifiability of behavior, the processes of learning, the springs of action, the interplay of personalities, the nature and distribution of individual differences in capacity, knowledge, skill, temperament and leadership throughout the population, both military and civilian. War may change its aspect with every generation. Drastic changes in the nature of man take place more slowly. This is why it is reasonable to suppose that as long as there is need for an army of occupation, a world police, or a system of national defense, just so long will there be technical problems of military psychology (*10*).

Based on an address before the Psychology Section of the New York Academy of Sciences, January 20, 1947. The views expressed are personal and not official.

Problems of Biomechanics

In connection with the *design of new equipment*, for instance, urgent psychological problems will continue to arise out of hard facts regarding the limits of human capacity. There are bounds to man's ability to perceive, to discriminate, to judge, to respond with the requisite promptness, and to manipulate handles, wheels, triggers, knobs, levers, and pointers with the necessary precision, without succumbing to the effects of avoidable fatigue and distress which have too often been inadvertently imposed by designers of military as well as of industrial equipment. Ordnance experts and development engineers will be under pressure to produce better, more effective weapons, vehicles, airplanes, instrument panels, scales, signals, radar screens, goggles for night lookout or scouting duty, and complex fire-control systems for use aboard ship or on shore. Designers wrestling with such problems during the past six years have not infrequently called upon physiologists and psychologists to bring to bear their insights, their knowledge of human capabilities, and their methods of scientific experimental attack (*4, 5, 6, 8*). Psychological development of procedures for the most *effective use of equipment*—for instance, of electronic aids—also proved to be valued by technical services of Army and Navy. As a consequence, tasks have been made less complicated, performance easier and more precise, with diminished strain. The usefulness of new equipment has been broadened, and the precious time required to master it has been shortened.

These types of contribution are vividly illustrated by the accomplishments of the Psycho-Acoustic Laboratory directed by S. S. Stevens at Harvard. This enterprise markedly improved the transmission of speech by telephones and interphone equipment, developed better headsets and earphones, found and demonstrated the optimal position of the microphone relative to the lips of the talker, ascertained the speech sounds most frequently misunderstood, devised superior oral codes, and helped to work up a short, intensive training course in telephonic speech which increased intelligibility and reduced the errors in vocal communications. It is no rash assumption that rigorous, systematic, ingenious, practical laboratory research of this kind will continue to be demanded by the military services.

A similar area is the *design of clothing and gear* adapted to the comfort, the convenience, and the mental as well

as the physiological capacity of the wearer when campaigning in the desert, in the tropics, or in the frigid polar regions, when escaping from a submarine, or when bailing out of a jet-propelled airplane in the stratosphere.

Developing ways of reliably *ascertaining preference for duty* in a region of bitter cold or in the steaming tropics is a related field of inquiry into which military psychologists have hitherto made only exploratory forays.

Does it really matter whether a soldier is going to like it in the far North better than he would in a tropical jungle? Should this factor of his personal preference be given any weight when deciding as to his assignments? Isn't it of the essence of military organization and discipline that each soldier goes where he is needed and does what he is told? The answer is known to every leader. He appreciates how greatly his own tasks of direction and command are simplified when his followers have had at least some share in choosing their arm or service, their military specialty, their assignments, and their comrades, and have identified their own objectives with those of their organization and its commander.

Resources of Man Power

This leads headlong into the military problem of *the discovery, development, and conservation of aptitudes*, of human capacities and talents of every sort.

To maximize the Nation's human resources by facilitating the growth and optimal utilization of potential capabilities is a worthy goal during any period of peace. If again the war clouds gather, it will become an imperative of survival. The United States has traditionally been extravagant of its man power, as of water power, forests, grazing lands, oil deposits, wild life, and other endowments. During World War II we wasted a good many people, both in essential industries and in the armed forces. Certain chemists needed for technical research were, for example, kept on duty in hospitals making routine laboratory determinations which a careful high school boy could be taught to do with precision in two days. Fortunately, in spite of wasted skills, we still had a little man power to spare after all the really indispensable activities had somehow been staffed. But never again! If we should find ourselves once more at war, it is likely to be the enemy who will have man power enough and to spare. So, within the next few years, we must place ourselves in a superlative position to husband our abilities and strength.

Slow Learners

Sharply defined psychological problems of man-power conservation are seen at the two extremes of the ability scale. Toward the lower extreme is the Army's number-one headache, the slow learner. From this category I exclude the feeble-minded. The imbeciles and the morons, together with the psychotics, the epileptics, the inadequate personalities, should have been debarred, and commonly were, at the Induction Stations. Slow learners were those who, having been accepted, found the going pretty tough during the early months of training, required a longer-than-average period of basic instruction, and, even then, in most instances had to be either dropped from the service or assigned to noncombatant duty as unskilled laborers because they did not have what it takes to be infantrymen in these days when so much depends on the knowledge and resourcefulness of the individual soldier.

A large majority of these slow learners were illiterate, not necessarily in the sense that they could not read or write their own names. They were functionally illiterate in that they could not read well enough to make any practical use of the Army's instructional aids, when trying to learn what a soldier must know. This is the Army's definition of literacy: the ability to read as well as the average person who has had the benefit of four years of elementary schooling. (Hence, one sees occasional reference to "fourth-year literacy.")

There were altogether too many of these functional illiterates. During 1941 and 1942, thousands of them had to be released. Others continued to congest the training centers long after they were supposed to be ready for assignment to units or sent overseas as reinforcements. Since the War Department well knew that reinforcements would be in great demand in 1943 and 1944, the military psychologists and educators undertook a heroic job of salvage. They developed ingenious schemes and practical devices with which to teach grown men to read and to figure (*9*). Eighteen Special Training Units were established with a capacity of 30,000 men. Expert instructors were appointed to oversee the teaching, which had to be skillful, intensive, swift. To these Special Training Units, beginning in the late spring of 1943, went all illiterate inductees and also all who, though able to read some, did not pass the Army General Classification Test with a standard score of at least 60, *i.e.* two sigmas below the mean.

It was found that a large proportion of these slow learners could be salvaged within a period of 13–17 weeks, in the sense that they actually learned to read at the fourth-year level and, on transfer to the regular training camps, were able to keep pace with the course of instruction. Between June 1943 and September 1945 a total of 218,000 of these illiterates and 69,000 others who had not made at least Standard Score 60 on the AGCT were dispatched to one of the Special Training Units immediately after being accepted for military service; and 83 per cent of them in three or four months time learned enough reading, arithmetic, and Army discipline to enable them to go forward on a military career, instead of continuing to be a drag on the war effort or having to be discharged.

Today America is confronted squarely with these two astonishing facts: first, the disappointingly high rate of

nctional illiteracy; second, a demonstration that this cial disease can be greatly ameliorated whenever we cide to pay the cost in effort and in dollars.

The military psychologists have done their part. The vilian economy must now pick up the burden. This is t only the task of providing excellent educational portunities for all the children, rural and urban, white d colored, north, east, south, and west; there is also e need of getting more than 1,000,000 young men w of military age over the barrier that separates the nctionally illiterate from the literate and the dis-essingly slow learners from the rest of us. This will ve to be done, if the Nation's resources of man power e to be maximized in this generation.

Rapid Learners

Studies of our civilian army make it clear that the ational economy also has unfilled obligations to a eat many young men who, on the AGCT, would score the top third of the distribution, in Army Grades I r II, *i.e.* Standard Score 110 or better. Within this pper range the armed forces find all their potential mmissioned officers and many able noncoms. Leaders civilian undertakings likewise tend to come from these ntellectual levels. Here are most of the successful rofessional men, scientists, engineers, architects, tech-ological specialists, general managers, editors, teachers, ocial workers, psychologists. More than half of the their schooling had not been interrupted, since half of the men in this sample had been only 18–24 years old when they joined the service. Nor does our coverage include those men who had gone to Officer Candidate School and been commissioned. Their records would have increased the proportions in Army Grades I and II and in the higher educational categories. Even so, the conclusion cannot be escaped that the number presumably having the intellectual capacity to benefit from higher education is substantially greater than the number actually permitted to carry their schooling into that zone of achievement.

TABLE 1

DISTRIBUTION OF 105,521 ENLISTED MEN BY TEST SCORE AND SCHOOLING

	AGCT Grade					Total
	V	IV	III	II	I	
A. College graduates	3	51	343	2,111	1,201	3,709
B. 1 to 3 years college	27	400	2,694	7,781	2,478	13,380
C. Finished high school	100	2,102	9,362	13,239	2,232	27,035
D. 1 to 3 years high school	757	8,184	12,533	7,508	624	29,606
E. No high school	6,354	15,765	7,446	2,076	150	31,791
Total	7,241	26,502	32,378	32,715	6,685	105,521

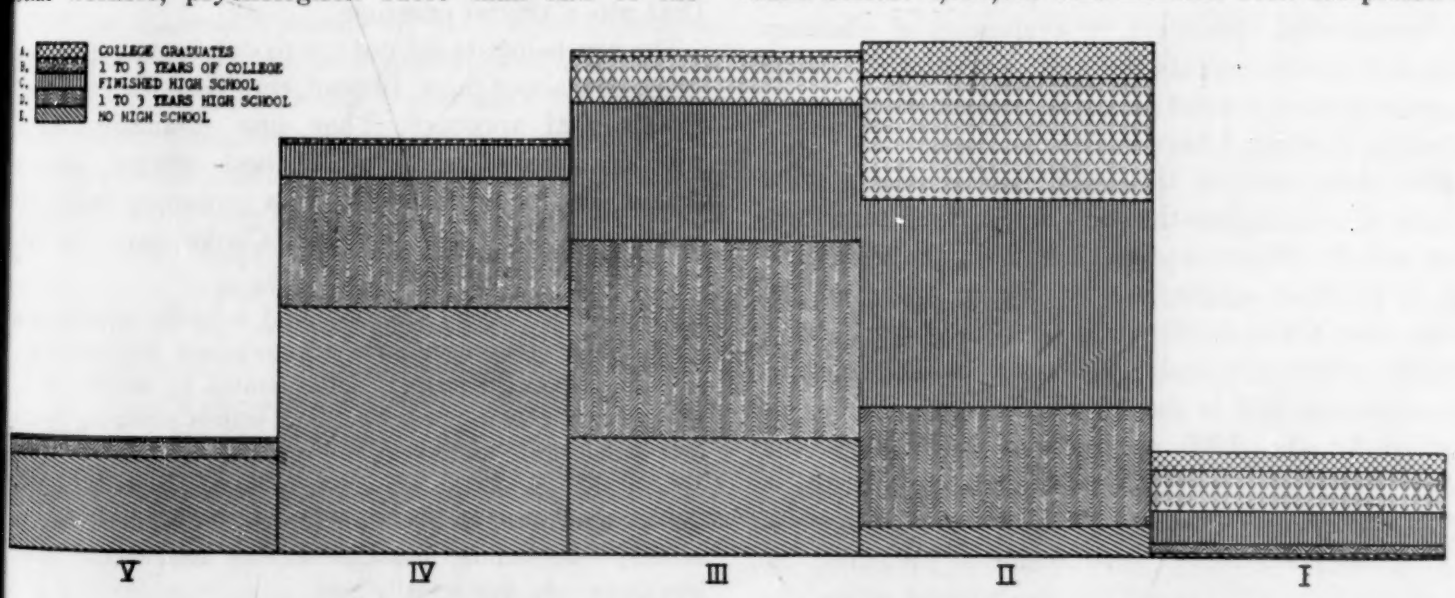

FIG. 1. Relation of learning readiness to educational level.

West Point Cadets are in Army Grade I; none is below Grade II. An overwhelming majority of college men score within this range. In Fig. 1 and Table 1 may be seen the relation of learning readiness as measured by this test to level of education achieved before entering the Army, in a population of 105,521 enlisted men constituting a thin cross section of the enlisted strength of the Army as of March 31, 1944. A large fraction of group B, those who had begun but not completed a college course, would have graduated in due time if high school course, much less gone on to a technological institute, a college, or a professional school (*1*). Why? For some, their calling, their vocation, had led elsewhere. Schools and colleges are not the only places in which education, cultivation, personal effectiveness, and professional competence can be achieved. But for the majority of these bright soldiers, the decisive reason for discontinuing their education had been economic. Here, then, is a pool from which to augment the Nation's short supply of scientists, technologists, scholars,

Another study discloses the sobering fact that, among more than 3,000,000 men in these higher levels of learning ability, the personnel classification interviewers found almost 1,000,000 who had not even completed a

professional men, and military leaders. An ample number of competitive scholarships providing for board as well as tuition would be one form of insurance against unnecessary waste of such intellectual resources. The National Science Foundation, if established, will help in some measure to meet this need.

Potential Leaders

The problem of selecting military leaders is not solely one of identifying the highly educated competitors, or the brightest. Indeed, beyond a certain indispensable minimum of knowledge and intellectual acumen, the factors which tend to differentiate the best officers from the very good are not measured with precision by means of tests of educational achievement or scholastic aptitude. This was one of the impressive findings from a notable research project of the War Department which had as its purpose the development of sound procedures for use in selecting from among the wartime officers those who would receive commissions in the Regular Army.

This study, ordered by the General Staff early in 1945, was planned in detail and carried to completion by The Adjutant General through the Personnel Research Section of the Classification and Replacement Branch of his office. It came to be known as the Officer Integration Project. Thirteen thousand officers collaborated as subjects in the field trials. Others took part as interviewers, examiners, or evaluators of efficiency. It was in many respects the most searching, thorough, ingenious, and fruitful research project in personnel selection of which I have knowledge.[1]

The story, told in the *Infantry Journal* by J. M. Clarke (*3*), emphasizes the stark necessity for procedures that validly differentiate the best from the very good; for in the first integration, which took place in June 1946, only about 9,000 could be chosen from among 108,582 officers who had filed applications. Competition was especially stiff in the Air Forces, where 59,000 had applied for the 3,900 commissions available at that time. The question was: Which ones among the superior applicants would be of greatest value to the service during the years ahead? Instruments of prediction had to prove their validity within the topmost range. Another challenging prerequisite was that choice had to be made by procedures which do not permit bias, prejudice, or favoritism to creep in and corrupt judgment.

[1] The following officers and professional staff members were immediately responsible for preparing and validating the procedures recommended for adoption: Lt. Col. M. W. Richardson, Lt. Col. D. E. Baier, Major Roger M. Bellows, Capt. Reign H. Bittner, Capt. E. A. Rundquist, Robert J. Wherry, William R. Wilson, Francis F. Bradshaw, Edwin R. Henry, Douglas H. Fryer, and Harold A. Edgerton. Indorsement of the recommendations of this technical staff was made, after careful study of the procedures and the results of the practical tryouts, by the following members of the Committee on Classification of Military Personnel Advisory to The Adjutant General: W. V. Bingham, H. E. Garrett, C. F. Hansen, L. J. O'Rourke, C. L. Shartle, and L. L. Thurstone.

Among the instruments which survived extensive experimental tryouts were: first, a General Survey Test of educational background, which served as a preliminary hurdle to screen some applicants from further consideration but which carried no weight in the final combined score; next, a very detailed Biographical Information Blank, on which many of the statements to be checked get at the candidate's attitudes toward himself, toward other people, and toward the work and career of an officer; third, an Officer Evaluation Report which utilizes several ingenious devices for securing information that is at once impartial and significant; and finally, a session with a practiced Interview Board whose procedures and ratings are concentrated on eliciting, observing, and reporting only those aspects of behavior which can be drawn out and reliably appraised during a group discussion.

These instruments had to be tailor-made, to fit the Army officer population. In the long biographical inventory lists and the officer evaluation reports, words and phrases were used which officers are known to employ when describing fellow officers of whom they approve or disapprove. Officers in the experimental population had been given a chance to write sketches about other officers, good and poor; and from about 800 such essays were culled phrases, trait terms, and characterizations to be tried out. Which of these actually apply to the best officers more often than to others? That was a crucial question.

The psychologists did not try to decide such questions by arguing about them. Instead, they used the empirical, experimental approach. They first established three criterion groups, made up of best officers, average officers, and poor officers, using a procedure called the nominating technique. As Mr. Clarke says (p. 10):

> There is no way of knowing that a leader actually is a leader until other men have acknowledged his leadership, and the acknowledgment is demonstrated by results. Those who are best able to judge whether a man is achieving results that demonstrate leadership are his fellow officers. It seemed certain that if all the officers in a battalion, squadron or similar unit rated a fellow officer as outstanding, he was actually outstanding, and that if they unanimously rated him as poor, he was actually poor.

With this as a basic working principle, War Department experts visited installations all over the United States and supervised the rating by their fellow officers as well as by their commanders of 13,000 wartime officers—many of whom had been in combat together. On 3,000 out of the 13,000 the ratings by all who made them were in close agreement. There were 1,127 outstanding, 1,019 mediocre (that is, near the average) and 854 poor. On the other 10,000 there was some, though often merely a slight, difference of opinion among fellow officers and superiors taken together. But on the 3,000 all equals and all superiors agreed. And when all a man's fellow officers and superior officers agree that he is outstanding (or mediocre, or poor) as a leader there is not much

doubt about it, especially when actual performance in combat and elsewhere is part of the basis for judgment.

The three groups among the 3,000 men (1,127 outstanding, 1,019 mediocre, and 854 poor)—groups of men who had all been rated with the greatest possible precision and practical care—were used in the final tryouts of the leadership tests.

It was required of every biographical item, test, or rating instrument that it contribute to the differentiation of these groups. For instance, it had been remarked of certain officers that they "had had Junior ROTC training in high school." But a check of biographical data showed that this statement applied equally often to officers in the poor, average, and best groups; so, into the wastebasket it went, along with many other characterizations. Only statistically significant items were given appropriate weights in the final scoring scheme.

Another step consisted in finding out what officers think as to which of these traits and phrases are the more laudatory or the more derogatory. After these data were systematically secured and the trait rankings brought into relation with the validity data, it was possible to select pairs of terms which match in that they are commonly considered to be equally favorable, but which are actually far apart in discriminatory effectiveness. Suppose, then, that we were to bring together into one cluster five of these terms, two of which are commonly considered to be equally unfavorable, two favorable, and one indifferent or intermediate. You are asked to check with a plus mark the term that most nearly characterizes you, and with a minus mark the one which least applies to you. Suppose, further, that you are a very superior officer. If you check this and all other items on the form conscientiously and accurately, the scoring scheme will give you a high rating. But if you are a superior officer in all respects except that you are not quite frank about yourself and decide to mark the items, not as truthfully as you can, but in the way in which you imagine that they had better be marked in order to get a high score, the consequence is that your score tends to be nearer the average or mediocre than it ought to be.

Similarly, suppose a Major is evaluating a Captain who is the poorest leader in his battalion, an officer he personally dislikes; and suppose, in order to rid the Army of such riffraff, the rater decides to mark the Evaluation Report in a way which he thinks will surely make the Captain out to be a very poor officer, instead of marking in each instance the trait term which most nearly characterizes this Captain and the one which least applies to him, as the instructions prescribe. Again the attempt to beat the game defeats itself. The final score tends to drift away from the bottom of the scale in the direction of the colorless average. This pairing of valid and invalid terms, matched for apparently equal value on a scale of desirability, marks a distinct step forward in the evolution of rating systems.[2]

How good is this program of selecting wartime officers for integration into the regular establishment? It appears, from evidence accumulated in 1945 and early 1946, that if traditional procedures had been used, approximately 70 per cent of the officers chosen would have been above average and 30 per cent subaverage; while of the 9,000 chosen with the new procedures, statistical analysis indicates that less than 2 per cent are in the subaverage category. Mr. Clarke mentions estimates of the money savings expected to accrue from the elimination in advance of so many mediocre officers. The new system should eventually save around $250,000,000. Inept leaders are an expensive luxury.

Still better tests of leadership will be constructed in due course. Already steps have been taken to improve the methods of evaluation developed for the integration project and adapt them to peacetime requirements for a periodic officer-evaluation procedure. Appraisal of leadership in noncommissioned officers is a related topic of current research, as is the selection of enlisted men for Officer Candidate School. In the *Army Information Digest* (7) is a crisp description of the forced-choice technique and other features now embodied in the Biographical Information Blank and the Evaluation Report as adapted to such purposes.

Other Continuing Problems

The problem of selection for *assignment in the higher ranks* is certain to be brought forward from time to time. Only recently an officer distinguished as a combat commander and also as a policy maker inquired: "How can we pick the best planners—officers of the rank of Lieutenant Colonel or higher—for duty on the General Staff? Several Generals here, and at other headquarters too, would like to know." Of course I countered by asking whether he could supply some authentic criterion groups: officers who have proved to be superb planners, and officers with similar assignments who have been unable to deliver the goods. With such a start, a typical inquiry might be made into the significance of detailed biographical inventory data, interest schedules, test performances, interview procedures, and rating items chosen with an eye to their possible validity as indicators of exceptional ability to think out plans. Which stigmata are really significant only research will tell—research conducted outside of the library and requiring close observation, ingenious experimental design, patient follow-up, and sound statistical analysis of all relevant data. This problem is one of many in the quest for superior talents—problems that call for scientific attack

[2] The principle was developed by R. J. Wherry, of the Personnel Research Section, Adjutant General's Office, who credits the germ of the idea to Paul Horst, supervisor of Personnel Selection Research, Procter and Gamble Company.

during a period of peace and tranquillity. A good time to mend the roof is between rainstorms.

Nothing has been said of the recurring and insistent problems of *clinical psychology*, a field of highest practical importance in any fighting force. Military psychologists specializing in this difficult subject are wanted today, not only in neuropsychiatric wards of Army hospitals, but also in the consultation services at training centers, to help in preventing minor maladjustments and forestalling serious mental illness. Their usefulness will increase with the completion of current and projected studies of exceptional behavior in relation to the psychiatrists' diagnoses, treatments, and follow-up.

The systematic study of *attitudes and opinions*, too, is a technical field not to be neglected by an army which aims to keep a finger on the pulse of its personnel. Opinions flow along. You can treat them scientifically or unscientifically. You ignore them at your peril.

Equally essential in war is contact with the mind of the enemy. How best can we monitor and analyze his broadcasts? How should we ascertain the effects of military campaigns or of different patterns of strategic bombardment on the morale of his civilian populations and his troops? What truths of ours, what ways of informing him, are our most potent weapons of *psychological warfare?*

If ever again America should approach the catastrophe of war, answers to these imperative questions of military psychology should already be at hand.

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Obituary

Sir Joseph Barcroft
1872–1947

With the death of Sir Joseph Barcroft on March 21, the School of Physiology at Cambridge, England, lost one of its most distinguished and best-loved members. A student of the founders of the School—Foster, Langley, and Gaskell—Sir Joseph, perhaps more than anyone else, preserved its traditions and, through the host of students and collaborators he attracted, brought those traditions to international recognition.

Joseph Barcroft was born on July 23, 1872, at Newry, County Down, Ireland. He received his early education at Bootham at York and the Leys at Cambridge. After receiving the B.Sc. at London he went to Kings College, Cambridge, in 1893 with an exhibition. There he gained first-class honors in Parts I and II of the natural sciences tripos and was graduated with the B.A. in 1896.

Barcroft then began to study the mechanisms which provide the tissues with oxygen, an aspect of physiology then unexplored at Cambridge and the one which formed his dominant interest during almost half a century of active investigation. The earliest studies were designed to estimate the rate of oxygen utilization by a variety of tissues—the submaxillary gland, the kidney, the pancreas, and the heart in activity and at rest. These, some of which were made alone and others in collaboration, provided the basis for the recognition in quantitative terms of what Barcroft phrased as "the call for oxygen."

With the cumbersome apparatus for the estimations of the blood gases available at the turn of the century, data on gaseous metabolism of tissues were hard earned. Extraction methods were time consuming and required relatively large amounts of blood. To facilitate his estimations, Barcroft devised and improved the differential manometer, an instrument which opened new possibilities for the study of tissue metabolism and one which today, either in its original form or Warburg's modification, is used in biological laboratories throughout the world for the study of the respiratory exchanges of small amounts of tissue as well as for following the reactions of isolated enzyme systems. The invention of the differential manometer opened the way for Barcroft's classical studies on factors affecting the combination of oxygen and hemoglobin, to which his attention was drawn by a desire to estimate the oxygen or pressure in tissues at rest and in activity. For this purpose he sought to use the dissociation curve of the blood, but the variations in the form of the curves he prepared, as well as those of others, led him to investigate the effects of acids and salts on the affinities

of hemoglobin for oxygen, a study which laid the foundation for our present knowledge of the role of chemical changes in the blood in the release of oxygen at the tissue capillaries.

From the physiology of hemoglobin, Barcroft turned his attention to a description of the circumstances responsible for the transfer of oxygen from the alveolar spaces into the red cell. Until about 1922, physiologists were divided in their views concerning the role of the pulmonary epithelium. The researches of one school, led by Haldane, appeared to support the view that the epithelium was capable of secreting oxygen into the blood; the other, including Keogh and Barcroft, that the epithelium acted as an inert membrane. The controversy, a classic in its freedom from prejudice and narrowness, was decided in favor of the latter view, by evidence provided in large measure by Barcroft's studies made on himself while he lived for several days in a glass chamber at reduced oxygen pressures, the essential blood samples being drawn from an exposed artery in his forearm.

Interest in the effects of reduced oxygen pressures on the body mechanisms providing oxygen to the tissues were also explored during two expeditions which Barcroft led, the first to Monte Rosa in 1911, and the second to the Peruvian Andes in 1922. Knowledge gained on these expeditions and in the laboratory was used by Barcroft in World Wars I and II to the direct advantage of his country by its application to aviation warfare. It also provided the basis for his interest in blood stores and his search for the source of red cells delivered to the circulating blood as the individual entered environments of decreased oxygen pressure. The classical researches on the spleen and the circumstances under which it stores or delivers red cells are now familiar to all who have an acquaintance with physiology.

Differences in the bloods of fetuses and their mothers and their apparent functional advantages led Barcroft to study the respiratory function of the blood in the fetus. The readiness to follow an interest "beyond the visible horizons," so characteristic of the man, served to develop the whole field of fetal physiology, including the functions of the placenta, the circulatory changes at birth, and the functional development of the nervous system. The results of his researches and those of his collaborators in this field—a field which some claim Barcroft established in its own right—are summarized in *Researches on prenatal life*, which appeared late last year.

All of these investigations were based upon simple ideas and questions and carried through with direct methods and simple techniques. They were not designed to gather details except in so far as they were essential for the development of method in technique; they were designed to reveal principles of function or integrations. Once these were at hand, Barcroft moved on to expand his chosen field of interest, leaving the intricacies to be explored by those with special knowledge.

The record of Barcroft's investigations has been said to be one of the most fascinating in the annals of science, for few investigators have revealed so much of themselves in their writings. His freedom from all that was artificial in life, his charity and warmheartedness, are nowhere better revealed than in the first edition of *The respiratory function of the blood*. Anyone who opens its pages joins him in the high adventure of investigation, for there the pitfalls and pleasures of research are presented in a fashion which has encouraged and will continue to encourage young men to find in the pursuit of science a worthy purpose in life. There are revealed the personal qualities which enabled Barcroft—and Michael Foster before him—to attract young men with special talents and to direct their attention toward problems they were peculiarly fitted to solve. His flare for presenting a problem simply and his readiness to encourage and assist young men to careers in physiology and the allied sciences drew to him a host of students and collaborators.

In the years following his student days and before World War I, when he served as demonstrator and then lecturer in the University, few students entered the Cambridge laboratory who did not work with him at some time during their stay. After the War and until he retired from the Chair of Physiology (which he held from 1926 to 1937, succeeding Langley), students came to his laboratory from all over the world, many of them from the United States. Through his pupils and collaborators from this country, his Dunham Lectures given at Harvard in 1929, and the Terry Lectures at Yale in 1926, Barcroft made a special contribution to the development of physiology here. This, together with his achievements as an investigator, was recognized by his election as a foreign associate of the National Academy of Sciences in 1939.

Many other honors came to Sir Joseph. He was elected to the Royal Society in 1910 and was awarded a Royal Medal in 1922 and the Copley Medal in 1943. He was knighted in 1935. Although he retired in 1937, his years of service to science were not at an end. His broad biological interests and his talents as an administrator were utilized during World War II, when he served on advisory committees of the War Office and the Royal Air Force. To the establishment of the Nutrition Society he gave his unfailing devotion and served as its chairman from 1945 until his death. When the Agricultural Research Council elected to promote fundamental research on the large, domesticated animals by the establishment of a Unit of Animal Physiology at Cambridge, Sir Joseph was chosen as its director. In this post, with undiminished vigor, Barcroft continued to look and "to venture beyond the visible horizon," his craft in full sail to the end, for he died en route to his home for luncheon after a full morning in the laboratory.

DONALD H. BARRON

Department of Physiology,
Yale University School of Medicine

NEWS *and Notes*

At ceremonies held on August 11 at Brookhaven National Laboratory ground was broken on the site of the first peacetime atomic pile, to be used for fundamental research in medicine, physics, biology, chemistry, and engineering. According to Lyle Borst, head of the group which designed the pile, it will contain a number of improvements which will make it the most flexible pile in the world. Although similar in general form to that at Oak Ridge, its neutron density will be several times greater. The air-cooled pile, which is expected to be in operation by mid-1948, will be housed in a building approximately 120 feet long by 100 feet wide and more than 6 stories high, flanked by two laboratory wings, each nearly 100 feet long. The total cost will be about $10,000,000. The H. K. Ferguson Company, designers and builders of the Oak Ridge thermal diffusion plant, will be responsible for engineering design and construction. Sumner T. Pike and William W. Waymack, members of the U. S. Atomic Energy Commission, addressed the group present for the ceremonies.

About People

Joseph H. Burckhalter, for the past five years coordinator of research in synthetic antimalarial drugs for Parke, Davis & Company, Detroit, has been appointed associate professor of pharmaceutical chemistry at the University of Kansas, effective in September.

Alan Hisey, of the Medical College of Alabama, has been appointed associate professor of biochemistry, School of Chemistry, Metallurgy, and Ceramics, University of Alabama, Tuscaloosa.

Edward S. Ross has been promoted from associate curator to curator, Department of Embryology, California Academy of Sciences, San Francisco; **Hugh B. Leech,** formerly of the Dominion Entomological Laboratory, Vernon, B. C., has been named assistant curator; and **Don Graeme Kelley,** Berkeley, has been appointed editor of the Academy's monthly publications.

Edward U. Condon, director, National Bureau of Standards, and **Detlev W. Bronk,** chairman, National Research Council, have accepted appointments as members of the Scientific Advisory Committee of Brookhaven National Laboratory. This Committee, created to assist and advise the director of the Laboratory, consists also of the 9 scientific members of the Board of Trustees (*Science*, May 9, p. 491).

Wilson Popenoe, director, Escuela Agricola Panamericana, Zamorano, Honduras, received the honorary D. Sc. degree from Pomona College at its last commencement.

Kinichi Watanabe, formerly of the University of Hawaii, has been appointed assistant professor, Department of Physics, Wabash College, Crawfordsville, Indiana.

Henry Quastler, radiobiologist, Carle Clinic, Urbana, Illinois, has been appointed half-time associate research professor of radiobiology, Departments of Zoology and Physiology, and Physics, University of Illinois.

George W. Stiles, head, Pathological Laboratory, Bureau of Animal Industry, U. S. Department of Agriculture, Denver, Colorado, since 1918, retired on June 30 after 45 years of service in the Department.

Harold C. Urey, Institute for Nuclear Studies, University of Chicago, has been named to represent the American Chemical Society on the U. S. National Commission for UNESCO.

C. L. Gazin, paleontologist, Smithsonian Institution, has begun a search for fossils in the Huerfano formation in southern Colorado. Among the specimens Dr. Gazin hopes to find are the tillodonts of the Eocene period, which are among the earliest known warm-blooded animals and which combined rat and bear characteristics.

Lowell T. Coggeshall, chairman, Department of Medicine, University of Chicago, has been appointed dean of the Division of Biological Sciences, which includes 13 Departments as well as the Zoller Memorial Dental Clinic, Nursing Education, the Food Research Institute, and the Institute for Radiobiology and Biophysics.

Robert M. Stabler, formerly assistant professor of zoology, University of Pennsylvania, has been appointed associate professor and acting chairman, Department of Biology, Colorado College, Colorado Springs.

P. B. Pearson, professor of biochemistry and nutrition, Agricultural and Mechanical College of Texas, has been appointed dean of the Graduate School, succeeding **T. D. Brooks.** Dr. Pearson assumes his duties September 1.

Grants and Awards

Derrick T. Vail, professor of ophthalmology, Northwestern University, and consultant to the Army Medical Department, was recently awarded the Legion of Merit for "outstanding services" as senior consultant in ophthalmology in the European Theater. The presentation was made by Major Gen. Paul R. Hawley, chief medical director, Veterans Administration, and formerly chief surgeon, European Theater of Operations.

Louis Schmerling, Universal Oil Products Company, Chicago, will receive the first Ipatieff Prize in chemistry on September 15, during the national meeting of the American Chemical Society in New York City. The $3,000 prize, honoring achievements in the study of catalysis or high blood pressure, was established by Vladimir N. Ipatieff, director, Ipatieff High Pressure and Catalytic Laboratory, Northwestern University, and Mrs. Ipatieff. The award, which will be presented to Dr. Schmerling for his contribution to the knowledge of catalytic reactions of hydrocarbons, will be given every three years to a chemist under 40 years of age.

J. C. Geiger, director of public health, City and County of San Francisco, has recently been awarded the Gold Cross of the Royal Order of Phoenix from the Greek Government, the Royal Order of

the Crown of Orange Nassau, officer grade, from the Queen of Holland, and the Meritorious Medal of the Canadian Legion of the British Empire Service League from the president of the Dominion Command, Ottawa, Canada, for his services and contributions to public health.

The School of Dentistry, Emory University, has received from the National Institute of Health a $3,655 grant, according to Dean Ralph R. Byrnes. The grant, to be administered by James A. Miller, associate professor of anatomy, will be used for an analysis of factors in the newborn influencing survival under anoxia.

The Jane Coffin Childs Memorial Fund for Medical Research has recently announced the following appropriations, totaling $62,764.50, for support of cancer research projects and fellowships for one year: Samuel C. Harvey, Yale University School of Medicine, $3,000 for statistical studies of cancer, and $8,500 for clinical and laboratory studies of cancer; Yale University School of Medicine, Administration, $1,000 for maintenance of the animal house; C. C. Little and P. A. Gorer, Roscoe B. Jackson Memorial Laboratory, $4,500 for continued study of the mammary tumor inciter by Dr. Little, and $250 for 3 months for continued study of immunological aspects of genetics by Dr. Gorer; Yale University School of Medicine, Administration, $500 for expenses of seminars of the Atypical Growth Research Unit; Eugene L. Opie, Rockefeller Institute for Medical Research, $4,000 for continued studies of changes in cells undergoing malignant transformation, and dietary influences on liver tumor formation; Robert G. Green, University of Minnesota Medical School, $5,000 for continued studies on the nature and mode of action of the milk agent; Alexander Haddow and associates, Chester Beatty Research Institute, Royal Cancer Hospital, London, supplement of $2,500 for continued support of the Institute's research program on chemical carcinogenesis, viruses and cancer, and chemotherapy of cancer; Owen H. Wangensteen, University of Minnesota Medical School, $5,000 for continued investigations of gastric carcinoma; Aubrey Gorbman, Barnard College, Columbia University, $800 (September 15–June 30) for continued study of atypical growth in the thyroid gland; Edwin D. Murphy, University of Tennessee School of Medicine, $4,660 for the continued study of the biological behavior of experimental and human tumors; Paul R. Burkholder, Yale University, $3,000 for the study of mechanisms of induction and propagation of atypical growth in plants; T. M. Sonneborn and W. J. van Wagtendonk, Indiana University, $8,500 for studies on the biochemical nature of substances concerned in transmission of hereditary cytoplasmic factors in *Paramecium*; William B. Atkinson and Howard C. Taylor, Jr., Columbia University College of Physicians and Surgeons, $4,000 for cytochemical investigations on hyperplastic and malignant uterine tissues in women in relation to their endocrine state; Joshua Lederberg, fellow, $1,554.50 (September 7–June 30) to work with Francis J. Ryan, Department of Zoology, Columbia University; Charles Grégoire, fellow, $1,500 (October 1–June 30) to work in the Department of Cancer Research, Rockefeller Institute for Medical Research; and $4,500 to cover various projects of the Fund. These appropriations bring the total project and fellowship allocations for the year 1947–48 to $171,308.66.

The Fund also announced the appointment on July 1 of M. C. Winternitz as acting director, Board of Scientific Advisers, succeeding Stanhope Bayne-Jones, who was appointed president of the Joint Administrative Board of the New York Hospital-Cornell Medical Center (see *Science*, June 27, p. 660).

Fellowships

A limited number of Fellowships in Medicine, designed to provide an opportunity for research training in the basic medical sciences or in their application to clinical investigation, will be available through the American College of Physicians from July 1, 1948 to June 30, 1949. Stipends will range from $2,200 to $3,000. The closing date for applications is November 1, 1947. Forms will be supplied on request to: The American College of Physicians, 4200 Pine Street, Philadelphia 4, Pennsylvania.

The American Association of University Women is offering a series of fellowships for graduate study or research for 1948–49. The National Fellowships are open to American women for study here or abroad, and the International Fellowships include one to enable a Latin-American woman to study in this country and others which are open to members of the International Federation of University Women. The majority carry a stipend of $1,500. Detailed information may be obtained from the Secretary, Committee on Fellowship Awards, American Association of University Women, 1634 I Street, N.W., Washington 6, D. C.

Colleges and Universities

Iowa State College plans to build a 3-story connecting link between the chemistry and physics buildings, joining the two buildings now housing integral parts of the Institute for Atomic Research, of which F. H. Spedding is director. The new building will contain spectrographic laboratories, facilities for tracer chemistry, reading room for the joint use of the Physics and Chemistry Departments and the Institute, staff and administrative offices, conference rooms, and research laboratories.

Stanford University has disclosed the development by Lester M. Field, electrical engineer, School of Engineering, and his staff of a traveling wave radio tube which could amplify simultaneously 250,000 telephone conversations or 300 black-and-white television broadcasts or 100 in color. The slender, foot-long tube, doubling the ability of earlier models to cover a wide range of frequencies and handle a huge volume of radio traffic, differs from ordinary radio tubes in that it provides a system of lengthy exposure of microwaves to a stream of electrons from which the microwaves build up their energy. The new tube will facilitate commercial expansion of television, since the vast number of frequencies it covers will enable many television stations to operate simultaneously. It also provides a feasible method by which long-distance lines can be replaced by a chain of radio relay stations in which the tubes will provide ample amplification and room for simultaneous transmission of large volumes of telephone and radio traffic.

The University of Notre Dame has established in its Department of Aeronautical Engineering a unique engineering flight demonstration program, designed to supplement theoretical principles of aerodynamics and airplane dynamics taught in the classroom with actual flying experi-

ence. Lt. Col. Francis X. Bradley, A. C. Reserve, instructor in mathematics, is providing instruction in flight demonstration in the air, while R. S. Eickenberry, associate professor of aeronautical engineering, is conducting a concurrent series of lectures to provide the theoretical basis for the flight program.

The New Mexico School of Mines has announced the following appointments to the teaching staff at Socorro: **John Harty,** formerly associate professor of physics, St. Louis University, as professor and head, Department of Physics; **Rafael Sanchez-Diaz,** formerly professor and head, Department of Mathematics, College of Agriculture and Mechanical Arts, University of Puerto Rico, as professor and acting head, Department of Mathematics; **William W. Long,** formerly an exploration engineer with the Freeport Sulphur Company of New York, as assistant professor of mining engineering; and **Albert A. Koch,** of Pasadena, California, as associate professor of engineering.

A $200,000 contract for leather research centering at the Tanners' Council of America Laboratory on the University of Cincinnati campus has recently been renewed by the Quartermaster General of the Army. This research program, which has been under way for several years, involves the following projects and institutions: University of Cincinnati—production of highly water-resistant leather for Army shoes, study of temperature and humidity conditions and their effect on leather held in stock piles, and development of synthetic tanning materials; Massachusetts Institute of Technology—basic research on the composition and structure of skins; Lehigh University—study of all mineral tannages; Ohio State University—development of artificial fat-like materials; Institute of Paper Chemistry—study of new tanning materials; Eastern Regional Research Laboratory, USDA, Philadelphia—improvement of military insoles; and U. S. Bureau of Standards—study of the increased wearability of leather by use of plastics and other resinous materials. Fred O'Flaherty, director of the Tanners' Council Laboratory, is coordinator of the program.

A special surgical unit for plastic and maxillofacial surgery and neurosurgery is being developed at the University of Texas Medical Branch, Galveston. This unit, which will probably be opened in September, was planned by the late Albert Singleton. It will be under the direction of T. G. Blocker, Jr., professor of plastic and maxillofacial surgery, and Samuel Snodgrass, associate professor of neurosurgery.

At the 95th annual commencement of the Woman's Medical College of Pennsylvania, held on June 6, Louise Pearce, president of the Board of Corporators, conferred degrees on 35 graduates. Carmen C. Thomas, president of the Alumnae Association, presented special citations to members of the Class of 1897, 7 of whom are still living. Dr. Pearce announced plans for the expansion program of the College, to be completed by 1950, the centennial of its founding. These include raising a $4,000,000 fund for general endowment and for physical expansion of facilities of both College and Clinic.

Meetings

The Fourth International Cancer Research Congress, which is to meet in St. Louis on September 2–7 (*Science,* August 8, p. 124) will have as its secretary general Frank McGurk, of Montgomery, Alabama. Mr. McGurk, on detached service with the Congress through August and September, is assistant regional director and state relations officer for the American Red Cross in Alabama.

The Pennsylvania Academy of Science, which held a well-attended meeting on the campus of the Johnstown Center of the University of Pittsburgh and Johnstown Central High School, April 4–5, was addressed by J. Kenneth Doutt, curator of Mammalogy, Carnegie Museum, Pittsburgh, on "Life on an Unexplored River in the Hudson Bay District." A symposium was held on flood control and soil conservation. The Junior Academy, which met at the same time, was attended by a large number of enthusiastic junior scientists from all parts of the state. The spring 1948 meeting is scheduled to be held at Grove City College; the summer 1948 meeting, at State Teachers College, Kutztown; and the spring 1949 meeting at Franklin and Marshall College.

The Eighth World's Poultry Congress will be held in Copenhagen, Denmark, in the summer of 1948. Morley A. Jull, Poultry Department, University of Maryland, who was recently elected vice-president, U. S. Executive Committee on the Congress, has explained that these Congresses are held under the auspices of the World's Poultry Science Association, an international organization composed of government poultry leaders, experiment station research workers, college teachers and extension personnel, and poultry producers and distributors. Regulations on the marketing of poultry products and the control of poultry diseases in the various countries are discussed, as are methods of conducting extension work among farmers and commercial poultrymen, and practical problems confronting producers in the breeding, feeding, incubation, management, and marketing of all classes of poultry.

The International Geographical Union is to hold its next Congress in Lisbon, Portugal, in September 1948. Among the topics to be considered are cartography, physical geography, biogeography, human and economic geography, colonial geography, the history of the subject, and methodology. Further information may be obtained from George B. Cressey, head, Department of Geography, Syracuse University, who has recently been appointed chairman of the National Committee of the United States. This Committee serves under the Division of Geology and Geography, National Research Council.

The Office of Naval Research is supporting a program of biological research at Pt. Barrow, Alaska, in a project called the Pt. Barrow Arctic Science Station. The initial biological program will be carried out by Laurence Irving, Per F. Scholander, Reidar Wennesland, Walter Flagg, and Erik T. Nielsen, of the Department of Zoology, Swarthmore College, and Donald R. Griffin and Raymond J. Hock, of the Department of Zoology, Cornell University, working under contracts between their respective institutions and the Office of Naval Research.

In order to assess the basic biological conditions of Arctic life, the party will study the metabolism of warm- and cold-blooded animals, the expenditure and economy of animal heat, and the orientation and metabolism of Arctic birds during migration. Following these studies through the transition from summer to winter and from winter to summer will give evidence concerning the basis for

biological acclimatization and adaptation to an Arctic environment, to the stresses imposed by climate, and to the profound and rapid seasonal changes which occur.

Pt. Barrow, the only station in the possession of the United States lying within the Arctic circle, faces an Arctic ocean with shores, waters, and ice biologically only little explored. Southward, the tundra land rising gradually to the Brooks Range has not been studied in its biological details. Over these regions modern transportation is rapidly extending geographical, geological, aerological, and oceanographic surveys, which provide clear outlines upon which to examine the patterns of Arctic life and its active adjustments to many of the high-latitude conditions which cover large and important areas of the earth. These areas have hitherto been screened from view by the difficulties of travel and existence. Now that Arctic outposts have become accessible, it is possible to carry on detailed and consistent studies of Arctic biology which will permit accurate descriptions of life in high latitudes. Scientific experience upon the cold frontiers of the North will also improve, by the contrasts which it presents, our knowledge of life in other climates.

According to Laurence Irving, director, Edward Martion Biological Laboratory, Swarthmore College, from whom the announcement was received, "it is believed that the initiation of this program will lead to sustained biological research in the Arctic which will develop the means for making human life in the Arctic more effective and more interesting."

The American Library Association, 50 E. Huron Street, Chicago, has just published a new *Subject guide to United States government publications*, by Herbert S. Hirshberg and Carl H. Melinat. The book, which sells for $5.00, presents documents by subject rather than by office of issue. The documents analyzed are selected from those of the last 20 years, with emphasis on the more recent ones and on subjects of continuing and current interest. Some 1,200 subjects are covered in its 236 pages, and many cross-references and bibliographies are included.

A new international journal of genetics is currently being published by Oliver and Boyd, Ltd., of London and Edinburgh. Bearing the title *Heredity*, the journal, which will devote itself principally to original articles, will appear three times a year. Volume I, Part I, was published in July. The editors are C. D. Darlington, John Innes Institution, London, and R. A. Fisher, Whittingehame Lodge, Cambridge, England. The first issue contains a section on genetic research in Britain, 1939–45; a bibliography of Italian and German research for the same period; and original articles by Th. Dobzhansky, Ø. Winge and E. Ditlevsen, D. Lewis, Otto H. Frankel, Sydney C. Harland, L. L. Cavalli and G. Magni, D. S. Falconer, and Margaret E. Wright. Single numbers sell for 14/–, or $3.00 net; an annual subscription, for 40/–, or $8.50.

The Helen Hay Whitney Foundation for basic scientific research in rheumatic fever has recently been formed. T. Duckett Jones has been appointed medical director of the Foundation, with temporary offices in the New York Hospital, 525 East 68th Street, New York City.

The formation and functions of the Associates of the Food and Container Institute were revealed at a press conference in Chicago on August 7. The new nonprofit organization, comprised of companies and corporations in the food, container, and allied industries, has listed the following objectives: (1) to promote the dissemination to industry of fundamental scientific information pertaining to foods and containers; (2) to function as a clearinghouse on research activities; (3) to attract scientists to engage in food and container research; (4) to ascertain fundamental research problems; (5) to minimize unnecessary duplication of research; (6) to keep members of the Associates informed of the Institute's activities; and (7) to assist the Institute with technical information relating to industrial experience and practice. The chairman of the Interim Board of Directors, which will manage the affairs of the Associates prior to a regular election, is Harry J. Williams, Wilson and Company, who is also chairman of the Executive Committee. Offices of the Associates are located at 1849 W. Pershing Road, Chicago 9, Illinois.

The Quartermaster Food and Container Institute now has projects under way in 15 institutions dealing with the discoloration of foodstuffs; 17 institutions are investigating the problem of rancidity; 13 are concerned with microbiological spoilage; 26 are working on nutritional deficiencies of foods; 24, on food acceptance research; and one project is devoted to the study of containers.

A new periodical publication appearing in two sections and entitled *Applied Scientific Research* will be published by Martinus Nijhoff, The Hague, The Netherlands, beginning in September. The two sections, (A) Mechanics, Heat and (B) Electrophysics, Acoustics, Optics, will provide a medium of publication for original technical-scientific investigations in these fields. Articles will be preferably in English, although French or German will be permitted. Subscriptions, which should be sent to the publisher, may be obtained for each section separately at 20 guilders (about $7.60) per volume. Manuscripts should be sent to the secretary, Dr. Ir. C. W. Kosten, Laboratorium voor Technische Physica, Mijnbouwplein 11, Delft. Published under the auspices of the Central Organization for Applied Scientific Research of the Netherlands, the Netherlands Physical Society, and the Royal Institute of Engineers, the journal will be supervised by a Governing Board, an Editorial Board, and a group of foreign editors.

The British Scientific Instrument Research Association formally opened its new laboratories last month. The laboratories are located at "Sira," Southill, Elmstead Woods, Chislehurst, Kent.

Make Plans for—

Mathematical Association of America, September 1–2, Yale University, New Haven, Connecticut.

Fourth International Cancer Research Congress, September 2–7, St. Louis, Missouri.

American Astronomical Society, 77th Meeting, September 3–6, Dearborn Observatory, Evanston, Illinois.

First International Biometric Conference, September 5–6, Marine Biological Laboratory, Woods Hole, Massachusetts.

American Psychological Association, September 9–13, Detroit, Michigan.

American Association for the Advancement of Science, 114th Meeting, December 26–31, Chicago, Illinois.

COMMENTS

by Readers

After many years of devastation China is now, with the help of the United Nations, effecting a recovery of her national well-being. This recovery involves the rehabilitation of her basic industries, among which her fisheries are of considerable importance. The rehabilitation of this industry involves not only building new vessels, assembling new gear, and organizing new marketing institutions to replace those destroyed during the war, but also developing an effective body of scientific data in relation to these fishery resources and the means of both production and distribution, to enable the fishery to be reorientated to the modes of fishing available today. Although powered vessels were operated in Chinese waters, from Chinese ports, before the war, the greater proportion of the industry was carried on by traditional methods, which, although comparatively effective, were in many cases primitive and incapable of any great development. Since little was known about the general resources, new developments were practically impossible, natural changes and fluctuations had to pass unexplained and merely endured, and no active program could be developed for the effective management of these resources. These problems are aggravated by the fact that, for various reasons, the move for the development of powered-vessel operations is of considerable urgency.

The Chinese National Fisheries Research Institute, recently established under the Ministry of Agriculture and Forestry, has been charged with the task of carrying out the investigations necessary to guide the Chinese fisheries industry during the difficult period of the immediate future and to serve as basis for permanent work in fisheries administration. Comprehensive plans have been drawn up for the conduct of research work and for the associated extension work by which the results of research can be communicated to the industry and a flow of recruits to the research field may be developed and maintained. However, implementation of this program is being seriously delayed by the lack of equipment and the inadequacy of a trained staff. The undersigned are therefore making a general appeal for assistance. At the present moment the Institute possesses hardly a measuring board, let alone the customary laboratory equipment for microscopic and other techniques. It possesses only a handful of books—generally Japanese—and has none of the standard fisheries publications. While the Institute plans eventually to acquire literature by purchase and exchange, such a program will necessarily be somewhat delayed and prolonged. It is thought that various individuals and institutions might be in a position to anticipate such a program by making gifts or exchanges in advance of any publication by the Institute. Any literature in general and marine biology, fisheries-biology, -economics, and -technology, hydrology, planktology, and related fields of oceanography, and limnology would be valuable to the workers of the Institute. It is less likely that gifts of equipment could be made. However, workers of the Institute would be grateful to be informed of any new techniques or special technical developments which workers in other laboratories have discovered. (LING SHAO-WEN, *Director*, GIDEON TING-WEI LEW, *Vice-Director*, G. L. KESTEVEN, *UNRRA Fisheries Operational Specialist, Shanghai.*)

Smith (*Univ. Kans. Publ. Mus. nat. Hist.*, 1946, **1**, 93–96) presents a well-drawn figure of the mouth parts of the tadpole of *Bufo cognatus* Say which differs materially from my figures accompanying the original description of this larva (*Copeia*, 1936, 14–30, Figs. 11–13). He also discusses the marked similarity between his figure of *B. cognatus* and Wright's figure (*Proc. U. S. nat. Mus.*, 1929, **74**, Art. 11, Pl. 5, Fig. 6) of a tadpole stated by the latter author to be *B. compactilis* Wiegmann.

Three possible interpretations are suggested by these facts: (1) Smith's tadpoles might have been of *B. compactilis*, (2) Wright's tadpoles might have been of *B. cognatus*, or (3) the tadpoles of the two species may have mouth parts so similar as to be practically identical.

Fortunately, I have at hand several large, personally collected series of the tadpoles of each species, all of which were fixed in the field in Bouin's solution and kept since in alcohol. All are in excellent condition. Those of *B. cognatus* were collected near Norman, Oklahoma, in 1941; those of *B. compactilis*, in various places in southwestern Oklahoma (chiefly in Greer County) in June 1946.

Even a superficial study of these tadpoles was sufficient to reveal the true situation. The third possibility is the correct one. The specimens from which my figures were drawn were atypical, and Smith's figure shows the typical condition. Dr. Wright's figure is also correct for *B. compactilis*, and his excellent description of color pattern and general external appearance of the tadpole of *B. compactilis* proves conclusively that he did not confuse the two species.

This situation raises interesting questions. Does the similarity in mouth parts of these two species of toads indicate a closer phylogenetic relationship than is commonly supposed? Broader than this, how much can larval characters in general be relied upon as indicating phylogenic relationships? How much similarity is due to convergent evolution in adaptation to similar habitats and ecological relationships? That no one can answer such questions with assurance at this time indicates certainly that tadpoles and other larval forms deserve much more study than they have received to date. (ARTHUR N. BRAGG, *University of Oklahoma, Norman.*)

P. Martens, well-known Belgian cytologist, and a director of the journal, *La Cellule*, writes that as the result of the war and the German occupation the future of the journal is in serious jeopardy. Issues have been appearing irregularly and at rather long intervals. Subscriptions have fallen off to a marked degree not only because subscribers in a number of countries have been unable to pay for them but because contacts have not yet been re-established with such countries as Russia, Germany, Japan, and Italy. It is to be hoped that cytologists will rally to the support of *La Cellule* and urge the purchase of subscriptions in their own institutions where such are not pending. (CLARENCE STERLING, *Department of Botany, University of Illinois.*)

TECHNICAL PAPERS

Adenosinetriphosphatase Activity of Human Serum[1]

ALTON MEISTER

National Cancer Institute, Bethesda, Maryland

Recent studies suggest that adenosinetriphosphatase (ATP-ase) plays an important role in muscular contraction (*3*). Attention has also been directed toward the significance of adenosine triphosphate (ATP) in the metabolism of other tissues (*2*), although apparently there have been no studies of blood serum. In the course of an investigation of the ATP-ase of human serum, a rather definite pH optimum was found at certain acid values of pH. This phenomenon has not been reported for the ATP-ase of certain animal tissues (*1*, *2*).

ATP, prepared and characterized as previously described (*8*), was used as the sodium salt. Serum from patients and presumably healthy subjects was prepared from venous blood, care being taken to avoid hemolysis. ATP-ase was determined in a system designed to make the concentration of enzyme the rate-determining factor. Five-tenths cc. of serum was added to 2.5 cc. of ATP solution in 0.1 M veronal-HCl or acetate buffer at various values of pH. Maximum activity was obtained with 3.38 and 9.67 micromoles of ATP at pH 8.9 and 4.8, respectively. After incubation at 37° for one-half to two hours, the clear trichloracetic acid filtrate was analyzed for inorganic phosphorus (*4*). Controls with buffer and ATP or serum alone were employed. The data presented are corrected for serum inorganic phosphorus and nonenzymatic hydrolysis and are expressed as micromoles of phosphorus split from ATP/cc. of serum/hour.

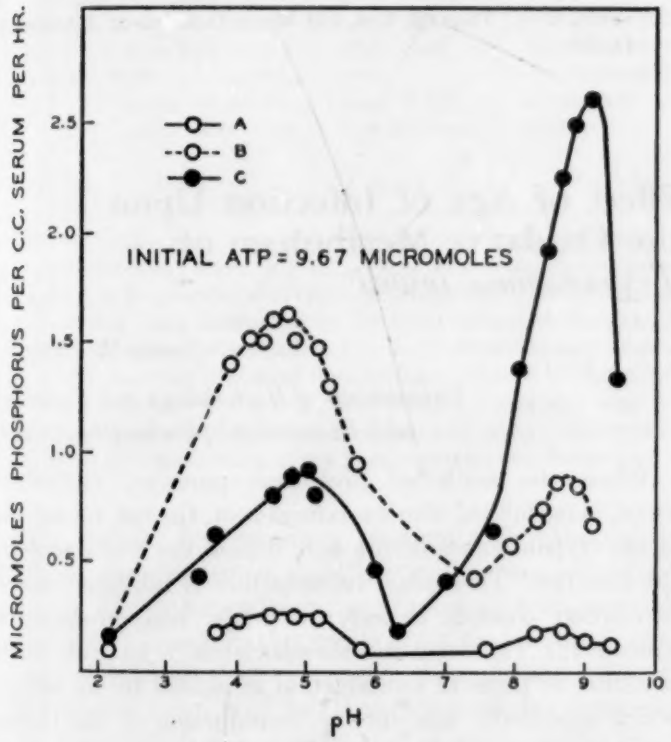

FIG. 1

Fig. 1 presents pH activity curves for the serum ATP-ase of a normal subject (A), a patient with cirrhosis (B), and a patient with metastatic carcinoma of the prostate (C). The activity exhibits maxima in the ranges of pH from 8.7 to 9.1 and 4.6 to 5.1 in all sera studied. At pH 8.9, all three phosphate groups of ATP are hydrolyzed by normal and abnormal sera, since the inorganic phosphorus liberated is greater than the decrease in acid-labile phosphorus. Furthermore, muscle adenylic acid is usually completely split under similar conditions. At pH 8.9, 0.29–0.32 micromole of adenylic acid was split (maximum hydrolysis = 0.32 micromole). On the other hand, the corresponding values at pH 4.8 were less than 0.06 micromole, except for sera with elevated "acid" phenylphosphatase, where the values were less than 0.18 micromole. There is no consistent relationship between ATP-ase at pH 4.8 and "acid" phenylphosphatase.

TABLE 1

ATP-ASE OF SEVERAL HUMAN SERA*

Diagnosis		Micromoles P/cc. serum/hour	
		pH 8.9	pH 4.8
Normal subjects†	1.....	0.18	0.26
	2.....	0.34	0.46
	3.....	0.19	0.38
	4.....	0.53	0.26
Prostatic carcinoma cases (bony metastases)	1.....	5.09	1.13
	2.....	2.86	3.0
	3.....	3.91	1.43
Breast carcinoma (liver metastases)		2.01	1.88
Cirrhosis.....		0.87	1.63
Infectious hepatitis		0.96	0.86

* These values were obtained with 3.38 and 9.67 micromoles of ATP at pH 8.9 and 4.8, respectively.

† The mean values for the sera of 21 presumably healthy subjects were 0.30 ($s \pm 0.1$) at pH 8.9 and 0.41 ($s \pm 0.1$) at pH 4.8.

In a preliminary study of various human sera, comparatively high values of ATP-ase were frequently found in patients with bone and liver disease (Table 1). However, the present data permit no diagnostic implications. The relative amounts of activity at pH 4.8 and 8.9 vary with different sera. In addition, greater amounts of substrate are necessary at pH 4.8 than at 8.9 for maximum activity.

The present evidence is compatible with the hypothesis that the two ATP-ase optima represent different enzymes. This was substantiated for the "acid" and "alkaline" phosphomonoesterases of beef kidney by Perlman and Ferry (*6*).

[1] This study was carried out at Gallinger Municipal Hospital, Washington, D. C.

Barrenscheen and Lang (*1*) found a specific ATP-ase in guinea pig and rabbit liver with pH optima of 8.2 and 9, while Satoh (*7*) reported that ATP was dephosphorylated by the combined action of phosphomonoesterase and pyrophosphatase. DuBois and Potter (*2*) report an optimum of pH 9 for rat liver ATP-ase. Studies of two specimens of pooled rat serum have failed to reveal an acid optimum for ATP-ase activity. It is possible that such species differences as have been found for prostatic phosphatase (*5*) exist with regard to "acid" ATP-ase.

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The Mode of Action of 7-Methyl Folic Acid

Gustav J. Martin, Leo Tolman, and Jack Moss

Research Laboratories, National Drug Company, Philadelphia, Pennsylvania

The primary action of sulfonamides (*1*) has been found to be directed against the incorporation of p-aminobenzoic acid into pteroylglutamic acid. 7-Methyl folic acid has been reported (*2*) as an effective folic acid displacing agent. The 7-methyl folic acid used in these experiments is N-(4-(((2-amino-4-hydroxy-7 - methyl - 6 - pteridyl) - methyl) - amino) benzoyl) - 1(+) - glutamic acid. To determine the mode of action of folic acid displacers, attempts were made to counteract the growth-inhibiting action of sulfonamides and folic acid displacers by various agents. *Staphylococcus aureus* # 209 grown in a bouillon medium was used as the test organism. Table 1 gives the results obtained.

TABLE 1

Counteraction of 7-Methyl Folic Acid and Sulfathiazole

Compound	p-Aminobenzoic acid	Pteroylglutamic acid	Pteroic acid	Glutamic acid	p-Aminobenzoyl 1 (+) glutamic	Sulfathiazole
7-Methyl folic acid...	+	+	+	−	−	+
Sulfathiazole.....	+	−	+	−	−	−

+ = counteracts
− = no effect

The concentrations per 10 ml. of chemicals used were: 7-methyl folic acid, 1–10 mg.; sulfathiazole, 0.05–1.0 mg.; p-aminobenzoic acid, 1–5 mg.; pteroylglutamic acid, 1–5 mg.; pteroic acid, 1–10 mg.; glutamic acid, 1–5 mg.; and p-aminobenzoyl-1(+)-glutamic acid, 1–5 mg.

When *Staph. aureus* is the test organism, it seems that the action of the sulfonamide is to prevent the incorporation of p-aminobenzoic acid into pteroic acid. Pteroylglutamic acid does not counteract the sulfonamide, which indicates that pte acid and not pteroylglutamic acid is involved in *Staphyloc* metabolism. The fact that p-aminobenzoylglutamic acid not counteract the sulfonamide would be anticipated if pte acid is the vital factor in growth. Pteroic acid is more effec than p-aminobenzoic acid in counteracting sulfathiazole.

With the same test organism, methyl folic acid is coun acted by pteroylglutamic acid, pteroic acid, and p-am benzoic acid but not by p-aminobenzoyl-1(+)-glutamic a indicating the synthesis of pteroic acid as the first step in formation of pteroylglutamic acid. Pteroic acid, p-am benzoic acid, and pteroylglutamic acid are equally effective a molar basis in counteracting methyl folic acid. It se probable that methyl folic acid interferes with the synthe of pteroylglutamic acid at the stage of pteroic acid formati and at the stage of union with glutamic acid. It has the furth capacity to displace formed pteroylglutamic acid. Thus, meth folic acid represents another displacement compound i corporating into one molecule the capacity to inhibit t synthesis of and displace a given metabolite. As with a sulfo amide, methyl folic acid interferes with the incorporation p-aminobenzoic acid into pteroylglutamic acid. The counte action of methyl folic acid by sulfathiazole indicates similari of structure resulting in mutual interference superseding th of interference with the metabolism of pteroylglutamic ac

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Effect of Age of Infection Upon the Oxidative Metabolism of *Trypanosoma lewisi*[1]

James W. Moulder[2]

Departments of Bacteriology and Parasitology and Biochemistry, University of Chicago

When the nonlethal protozoan parasite, *Trypanosoma lewisi*, is inoculated into its natural host, the rat, reproduction of the trypanosomes occurs only during the first few days of the infection. Thereafter, reproduction is inhibited, and the population consists entirely of adult, nonreproducing organisms (*2*). Taliaferro and his associates (*5*) have shown that cessation of parasite reproduction is caused by an antibody which specifically inhibits the reproduction of the trypanosomes, and in 1932 Taliaferro termed this antibody ablastin.

In an investigation of the mechanism of action of ablastin upon *T. lewisi*, the oxidative metabolism of trypanosomes taken from rats at different ages of infection has been compared. The study was limited to infections 2–10 days of age in which no number crisis had been brought about by the appearance of trypanolysins (*1*). Reproduction of the trypanosomes ceased on the fourth or fifth day of infection. Table 1

[1] Supported by grants from the Dr. Wallace C. and Clara A. Abbott Memorial Fund and the John Rockefeller McCormick Memorial Fund of the University of Chicago.

[2] Mr. and Mrs. Frank G. Logan Research Fellow.

ows that, compared with young reproducing organisms, adult nonreproducing trypanosomes respiring on glucose ve a higher rate of oxygen uptake, a higher respiratory otient, and an increased sensitivity to malonate inhibition oxygen uptake. These differences are all statistically sigficant. The increased rate of oxygen consumption per 10^9 ganisms may be due to the fact that the mean size of trynosomes in young infections is less than that in old ones (*4*),

TABLE 1

Day of infection	Oxygen uptake: No. observations	Oxygen uptake: Mean oxygen uptake (micromoles/10^9 organisms)	Respiratory quotient: No. observations	Respiratory quotient: Mean R.Q.	Inhibition of oxygen uptake by 0.01 M Na malonate: No. observations	Inhibition of oxygen uptake by 0.01 M Na malonate: Mean inhibition (%)
2	4	46	3	0.76	3	13
3	7	49	2	0.75	2	10
4	6	42	1	0.95	1	15
5	5	63	1	0.92	1	23
6	3	54	1	0.75	1	22
7	1	79	1	0.99	1	11
8	5	63	1	0.94	1	18
9	2	65	1	0.91	1	28
10	3	56	2	0.98	2	27
Arrangement of four-fold tables	Under 5 days—5 days and over Under 55 micromoles—55 micromoles and over		Under 4 days—4 days and over Under 0.85—0.85 and over		Under 5 days—5 days and over Under 18 per cent—18 per cent and over	
P	0.015		0.012		0.011	

Each Warburg vessel contained 0.75–1.50 × 10^8 trypanosomes in 1.0 cc. Ca-free phosphate saline (pH 7.6, 0.130 M total cation concentration) containing 0.01 M glucose and 2.0 per cent bovine serum albumin. Oxygen uptake and R.Q. were determined by the direct method of Warburg. Observations were started after equilibration for 15 minutes in an atmosphere of air at 37.5° and were continued for a period of 120 minutes. To test the statistical significance of the differences between young and adult trypansomes, χ^2 and P were calculated from four-fold tables, constructed as shown above after application of the Yates correction for continuity.

but the changes in respiratory quotient and malonate sensitivity are independent of variations in the mean size of trypanosomes. The malonate inhibition of respiration is interesting, because it is believed that succinate is not oxidized by *T. lewisi* (*3*). Added fumarate does not relieve the malonate inhibition.

The possible relation of the changes in oxidative metabolism to the inhibition of the reproduction of the parasites by the specific antibody, ablastin, is now being investigated.

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Fluorescence of Red Blood Cells

D. H. Hamly
Department of Botany, University of Toronto
George J. Hummer[1] and Charles Sheard
Division of Physics and Biophysical Research, Mayo Foundation, Rochester, Minnesota

Keller and Seggel and also Seggel (*3*) reported on the presence of red fluorescing reticulocytes in the blood of man and of animals. The significance of these fluorocytes in relation to the problems of anemia aroused the interest of many investigators, and by 1940 there had appeared an extensive series of German and French contributions on this subject. The articles by Seggel, Ungricht, Chytrek, and Watson, Grinstein, and Hawkinson (*4*) are of particular interest because of their views on the relationship between the number of fluorocytes and other clinical findings.

After the appearance of certain peculiar cases of anemia at the Mayo Clinic it was thought that Seggel's method of fluorescent examination might be of assistance. Accordingly, there was set up a fluorescence microscopic ensemble which permitted the satisfactory examination of fluorescing coproporphyrin mounted on a quartz slide. When, however, no fluorocytes were observed in the blood specimens of clinically selected cases, in newly-born guinea pigs, or in rabbits poisoned with phenylhydrazine, it seemed possible that this was due to inadequacy or insufficiency in one or both of the following: (1) absolute brightness of the fluorescence microscopic image, and (2) image contrast, brightness level, and the resolving power of the eye under very low illumination. Although one of us had considered similar problems with the ordinary light microscope (*1*), it was thought that these problems in the case of the fluorescence microscope were peculiar and required careful experimental analysis. An analysis of the factors involved in fluorescence microscopy is reported in another communication (*2*).

During the course of our investigations, in which we were able to increase the intensity of the ultraviolet illumination through the selection of better optical components, sources of radiation, and instrumental arrangement, various examinations were made of blood samples clinically selected as being anemic. Each sample of fresh blood was examined after dilution with physiologically isotonic saline solution. Sufficient dilution was required to permit the cells to lie flat. No other method of dilution was used, since Seggel had found that any kind of isotonic saline solution could be used if sublimate was absent.

Examinations of the fluorescence of samples of blood from a newborn guinea pig, from a rabbit poisoned with phenylhydrazine, and from a patient suffering from pernicious anemia gave negative results until an adequate intensity of illumination was obtained. Under favorable conditions, brightly fluorescing reticulocytes were observed. In the case of samples of blood drawn from a rabbit to which phenylhydrazine had been administered on three separate occasions during the course of four days, it was estimated that the fluorocytes were about 1 per cent of the erythrocytes observed. High intensity of illumination, accurate focusing, and proper dark adaptation of the eye must be obtained and maintained in order that fluorocytes of low order of fluorescence may be observed.

[1] Formerly a Fellow in Surgery, Mayo Foundation. Present address: Beverly Hills, California.

As already reported by Seggel, fluorescence of blood cells is an evanescent phenomenon, and its duration is related to the original brightness. In the case of the longest period of fluorescence of a fluorocyte observed by us, it was found that 120 seconds elapsed before the fluorocyte was too faint to be seen. In contrast, about the shortest time involved in a low-order fluorescence was only 4 seconds. While these data are considerably more extreme or of a wider time range than those reported by Seggel in the case of a rabbit to which phenylhydrazine had been administered, it cannot be concluded that, in our experiments, more coproporphyrin was present in the fluorocytes. It is probable that the conditions of observation were different in two particulars from those under which Seggel worked: (1) intensity of illumination and (2) level of dark adaptation.

Samples of blood from a patient having pernicious anemia were examined under optimal conditions and with the benefit of previous experiences in this type of investigation. Although fluorescence was observed, it was of a yellowish-green hue similar to that of willemite and not the red fluorescence characteristic of coproporphyrin. Although the significance of this yellowish-green fluorescence is not known to us, the presence of a brightly fluorescing yellowish-green pigment in a reticulocyte undoubtedly indicates the presence of some other modification of the normal hemoglobin of red blood cells.

The number of fluorocytes per unit volume of blood cannot be correlated with the amount of fluorescing pigment in the blood. This statement is deduced from the probability that the total time of visibility for fluorescence per unit area under constant intensity of illumination is roughly proportional to the fluorescing pigment present. This being the case, if the population is one of fluorocytes of uniform size, the total statistical time of fluorescence should be proportional to the amount of pigment per unit volume. These considerations would explain the lack of correlation between the fluorocyte count and other clinical findings in the evidence submitted by Seggel and others and would offer a basis for the criticism of Seggel's work by Chytrek. These considerations are especially pertinent, since in no case is it possible to determine the correct total time of fluorescence. The number of reticulocytes carrying the reddish fluorescent pigment must be in excess of those observed, since some cells will contain so little of this pigment that fluorescence will be below the level of visibility or will last for too short a period to permit recognition. In general, however, the number of fluorocytes which can be observed may be taken to indicate the severity or the state of the disease.

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IN THE LABORATORY

Improved and Improvised Sterilizing Containers for Bacteriological Petri Dishes and Pipettes

IVAN C. HALL

Dublin, Georgia

In spite of the close of the war it is still difficult to obtain such simple and relatively inexpensive items as sterilizing containers for bacteriological Petri dishes and pipettes, and some of those available have a common defect which this writer has observed for several years and now wishes to record so that manufacturers may correct it if they wish to do so.

For example, one type of round Petri dish container, 10 inches tall, has a lid 2½ inches high which slides over 1½ inches of the container. The lid fits so closely that its removal is often extremely difficult. A lid ½ inch high would be just as effective and would save much effort in handling. There is on the market an aluminum container, without a rack, with a shallow lid for four dishes, which is quite ideal. It is cheap, durable, and altogether satisfactory.

Some commercial containers for pipettes are open to the same kind of criticism as that just mentioned for Petri dishes. One sample has a cover 6 inches long, of which 2 inches fit over the container. Both container and cover are finely made of copper, are seamless, and are almost as closely fitted as a piston in a cylinder. It generally requires considerable effort to close or open one of these, and the upper third of the pipettes is exposed to aerial contamination when the lid is off, if they do not actually fall out.

Another container, made of stainless steel, not seamless, is 17 inches long, with a lid 1½ inches long and a sliding area of 1 inch. This is much easier to handle and exposes only ½ inch of the pipettes to the air. A loosely fitting lid ½ inch long with a short screw would be even better.

The writer has often used as containers for pipettes the discarded cartons in which adhesive tape or surgical plaster have been purchased. Some of these have shallow screw tops, and they will stand repeated sterilization in the dry air sterilizer very well, but not in the autoclave.

They are particularly useful for sterilizing Pasteur pipettes, but are too short for standard commercial pipettes. This difficulty has been met by lengthening them with an additional section fastened with Scotch tape, which also withstands repeated dry air sterilization remarkably well.

Coffee cans make very satisfactory substitutes for the commercial containers for Petri dishes, but they should first be boiled in a strong solution of lye to remove the lacquer.

A Method for Determining Sensitivity to Penicillin and Streptomycin[1]

ROBERT E. HOYT and MILTON GJELHAUG LEVINE

The Institute of Experimental Medicine,
College of Medical Evangelists,
Los Angeles, California

The sensitivity of a microorganism to penicillin or streptomycin is an important consideration in determining the choice of a chemotherapeutic agent. Furthermore, the development of resistance during the course of therapy may make it advisable to modify dosage or to change drugs. The imperative need for this information has led to the development of a number of methods which can be used to measure sensitivity. These follow the general pattern of making a series of dilutions of the drug in some nutrient vehicle and then inoculating the medium with a culture of the organism being tested. Sensitivity is shown by a failure to grow in one or more of the dilutions. Existing methods are cumbersome and require the use of a sterile technique. Since a pure culture of the organism being examined is needed, testing may be delayed for several days.

To overcome these objections we have incorporated penicillin and streptomycin into compressed tablets 7/32 inch in diameter and weighing 60 mg. each. The tablet base found

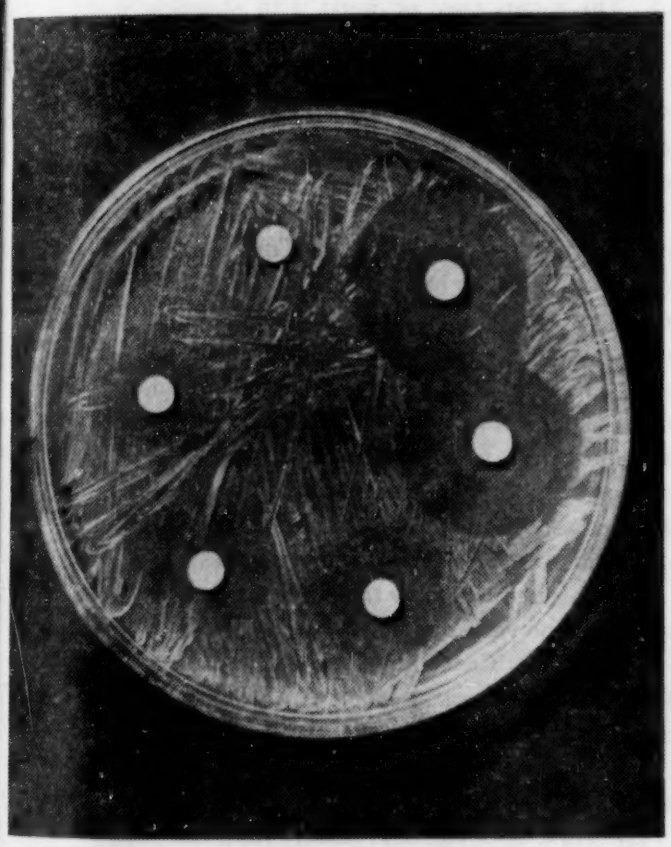

FIG. 1. Sensitivity of *Staphylococcus aureus* to penicillin and streptomycin. From the top, reading clockwise, the tablets contain 1.0, 0.5, 0.1 Oxford units of penicillin, 1.0, 0.1, 0.01 mg. of streptomycin.

to be most satisfactory contains dicalcium phosphate, starch, and gum acacia. The granulation is dried and passed through a fine screen, after which the calculated amount of the dry antibiotic agent is added and mixed thoroughly. To obtain an indication of the relative sensitivity of the organism, tablets containing varying amounts of drug were prepared. We have used penicillin tablets containing approximately 1.0, 0.5, and 0.1 Oxford units, and streptomycin tablets containing 1.0, 0.1, and 0.01 mg., respectively. Susceptibility of the organism to the drug is shown by a clear zone around the tablet (Fig. 1) which has a diameter proportional to the amount of drug contained.

The use of the tablets is very simple. An agar plate is streaked heavily with the organism being tested, and the tablets are dropped into position with forceps. The plates are incubated after inversion and are read when growth of the organism is sufficiently advanced to disclose susceptibility or resistance. Any type of solid media can be used as the base, since the results can be read by reflected light. We do not regard the precise measurement of the inhibition zone as being important, since its only value is the suggestion it may give as to therapeutic dosage. We have made no effort to sterilize the tablets before use. The growth of contaminants around the tablet is uncommon and, in any event, does not interfere with the observation. A control tablet containing only the ingredients of the granulation was run routinely for a while, but since there has never been any inhibition around it, we have discontinued this practice.

An important advantage which this method offers is the speed with which results may be obtained. Material such as sputum, exudates, and infected body fluids can be tested directly without preliminary subculture, since, even if contaminating bacteria are present, the various sensitivities can be observed.

[1] This work was aided by a grant from Boyle and Company, Los Angeles.

Sea Water Systems at Marine Laboratories

G. E. MACGINITIE

William G. Kerckhoff Marine Laboratory,
California Institute of Technology, Corona Del Mar

Since many salt water systems are being installed or remodeled throughout the world, a few suggestions concerning installation and materials should be timely.

The selection of metals to be used in such a system depends on their toxicity to animals and how rapidly they go into solution or combination with salt water ions to form toxic substances. Also, there is great variation in the amount of impurities carried by different metals. For example, generally speaking, cast iron from our West Coast is made mainly from scrap and carries a much greater percentage of impurities than does the pure eastern cast iron. From our experience with different metals, lead, tin, and pure-grade cast iron are the only ones that we feel safe in using where contamination must be held at a minimum, and even cast iron should not be left long in contact with salt water. Some metals having particularly bad lethal effects on larval forms are copper, zinc, and aluminum. Therefore, no brass or bronze fittings should be used in the salt water system where the water is expected to be used for experimental embryology. Monel metal, Inconel metal, etc. contain copper; stainless steel is also undesirable. Dishes made of such metals could not possibly be used safely for the culture of larvae, and this is our test for their safe use in any part of a salt water system. I therefore recommend that they not be used.

In purchasing metals such as lead, tin, or cast iron for use in a salt water system, pure grade should be specified and, if possible, tested out as containers for culturing larvae—for example, those of sea urchins. If a dish made of the metal

being considered can be used safely for culturing larvae over a period of two weeks, it can be used safely in the salt water system. It should be thoroughly washed before using. Such tests, of course, include a change of pure sea water every 12 hours, and the sea water should be passed through a nontoxic filter and come in contact only with clean glassware. Pure sea water should be obtained, even at a considerable distance at sea if there is any doubt as to harbor or shore contamination. This sea water should be filtered immediately and then may be kept in clean carboys for a long period of time. Such tests should be carried on at uniform temperatures equal to, or slightly below, that of the open ocean water in the vicinity of the laboratory.

An efficient salt water system at a marine laboratory is the nucleus upon which the activity of the laboratory depends, and too much care cannot be exercised in its efficient operation. One is justified in looking with suspicion upon experiments performed where impure salt water is used.

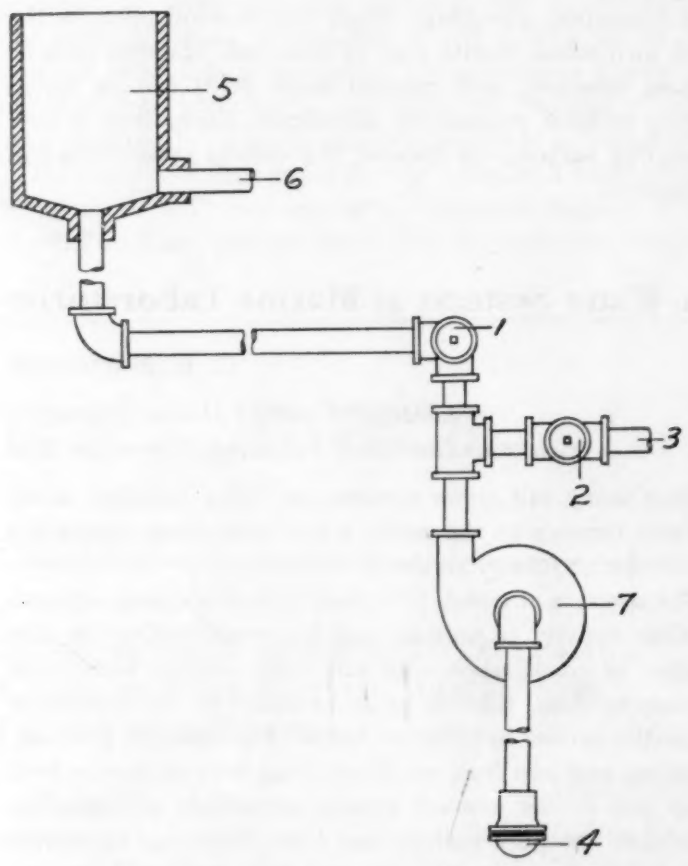

FIG. 1. Diagram of a salt water system: 1 and 2, cast iron stopcock valves; 3, drain pipe; 4, foot valve; 5, storage tank; 6, lead pipe to aquariums; 7, pump.

There are several fundamentals which should be carefully considered:

(1) The laboratory should be located near an available source of clean sea water.

(2) The pipe from the source of salt water should be of the proper material and should be as short as possible.

(3) Arrangements should be made for flushing this pipe before pumping more water into the storage tank (Fig. 1).

(4) The storage tank should hold sufficient water for about 1½ days. Even if the tank is larger, only enough water to last for that length of time should be pumped in each day.

(5) The lowest level in the storage tank should be 10 feet or more higher than the aquariums.

(6) Lead pipe and rubber stopcocks should be used from the storage tank to the aquariums.

(7) Hot water should be used to flush the pipes from the aquariums to the storage tank.

(8) The storage tank should be properly constructed of non-lethal materials.

None of these requirements increases the cost of installation or operation of the system; in fact, the cost is decreased. Exclusive of the work of one man for 70 days, the system at the Kerckhoff Marine Laboratory cost $958 in 1933. The sea water at the aquarium tables is as pure as the outside ocean water and is never more than 1°C. higher than the outside water. This system supplies two large laboratories, two smaller laboratories, a large aquarium, and a large live tank for storing animals.

A further discussion of the fundamentals listed above follows:

(1) Too many marine laboratories are built from an architectural standpoint rather than for a utilitarian purpose. If a marine laboratory is to function as such, it must be close to ocean water.

(2) Pure cast iron pipe should be used from the source of sea water to the storage tank. Lead-lined pipe is preferable if the salt water line to the storage tank is more than 300 or 400 feet long. This pipe should enter the *bottom* of the storage tank. The pump may be lined with stainless steel or with rubber. At this Laboratory a good cast iron pump has lasted 15 years and is still operating efficiently. It is advisable to have everything connected with the intake, pump, valves, and discharge into the storage tank of pure cast iron, for then there is no danger of electrolysis.

We use 3-inch intake from ocean to pump and 2½-inch pipe from pump to storage tank. Three to 5 h.p. is sufficient for such a pump for heads of 40–70 feet. If a larger pump is used, 5 or more h.p. is necessary, depending on the size. A pump running continuously can be used, but is not to be recommended. If the pump should lose its prime and the water remain off for a few hours, months of labor may be lost as a result of death to experimental animals. If a continuous pumping supply of water is used, a duplicate pump and motor are a necessity. Also, some type of stand pipe with overflow to maintain constant pressure is desirable, although regulation of a sort can be effected by the use of a valve or valves. Neither gate nor globe valves should be used here or in any other part of the system. Cast iron stopcock valves are much more efficient and last years longer. Any pump manufacturer will furnish engineering advice free.

Many types of alarm may be used with the system. We use a ½-inch overflow pipe coming out of the storage tank at just below full level, the pressure from the overflow tripping an alarm switch. Such a switch could be used on a float in the storage tank or in a stand pipe. A bucket-like trap that would fill and by its weight close a valve and also set off an alarm would be simple to make.

(3) Flushing may be illustrated by Fig. 1. By first opening valve 2 and then valve 1, water is allowed to flush the pipe from the storage tank to the drain (3). By closing valve 1 and starting the pump, the pipe from the foot valve through the pump is flushed out through the drain. By opening valve 1 and closing valve 2 with the pump running, the water being pumped is directed to the storage tank. All valves should be opened or closed easily to avoid water hammer. Either a good

foot valve should be installed at the point of intake and changed at low tide every two months or a short, flexible, rubber pressure hose should be used so that a change can be made at any stage of tide. It is necessary to have two foot valves so that one may be used while the other is being cleaned.

(4) One of the greatest mistakes made in salt water systems is the use of too large a storage tank. Salt water rots on standing, and the resulting chemical and pH changes are lethal, particularly to larval forms. If practically all of the stored water is used daily, the aquariums will remain sweet and the living material will flourish. If the storage tank is not too large, and if the pipe is flushed before pumping, the water will remain pure even though it is necessary to use a rather long cast iron pipe from the source of salt water to the storage tank.

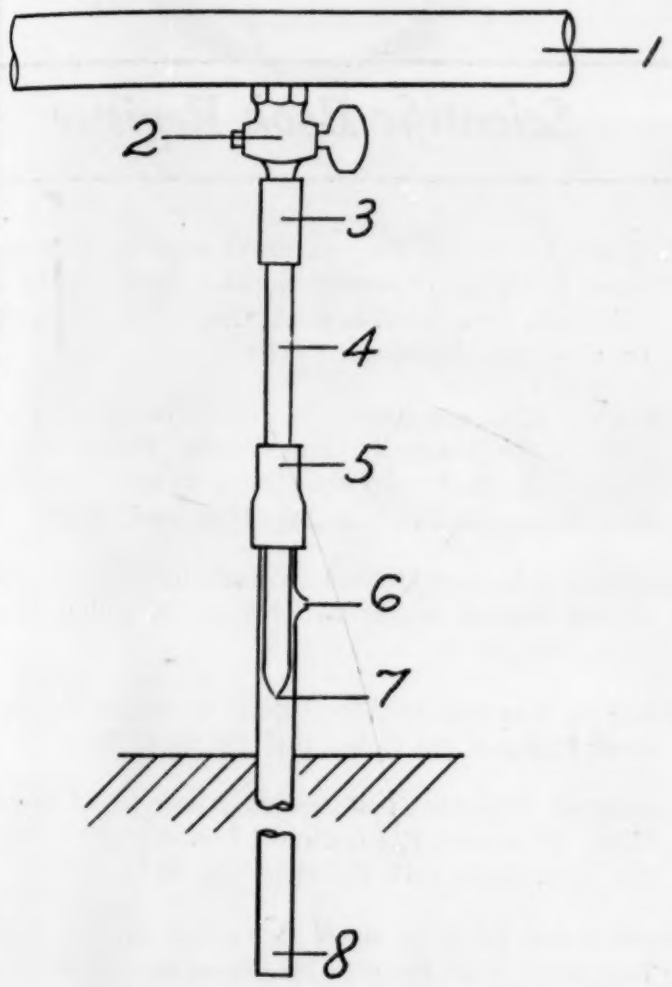

FIG. 2. Aerator for aquariums: 1, lead pipe over aquariums; 2, rubber stopcock; 3, rubber tubing connector; 4, glass tubing; 5, rubber tubing connector; 6, vent hole; 7, jet; 8, end of glass tubing near bottom of aquarium.

Organic material may be removed with filters, thus preventing some decay with its resultant ill effects, but these are expensive to install and keep up and are unnecessary if the above precautions are observed. Filters hold organic material which putrefies, and the products of decomposition wash through and contaminate the system.

Only slightly more salt water than will be used in the next 24 hours, more or less, should be pumped into the storage tank. Considering the location of most laboratories, that is, within a bay, water should be pumped just before or at high tide.

(5) Ten feet of head will provide ample force for aeration within the aquariums. After years of trial with many types of aeration devices, we use the rather simple setup shown in Fig. 2.

(6) *Thick-walled* lead pipe is most suitable, and less expensive in the long run, for conveying the sea water from the storage tank to the aquariums. Burning connections onto lead pipe can be done only by an expert workman and makes thin-walled pipe cost more than thick-walled pipe. This pipe need never be more than 2 inches in diameter; pipes to the separate aquarium tables, not more than $\frac{3}{4}$ inch in diameter. The largest pipe in our laboratory is $1\frac{1}{2}$ inch. Carrying capacity varies as the square of the diameter; therefore, a 2-inch pipe will carry nearly twice as much as a $1\frac{1}{2}$-inch pipe (all inside diameters).

Joints in the lead pipe are made by using bolt flanges and belling the lead over the sides to be joined together. Thus, when the flange bolts are tightened, lead comes against lead, and throughout the entire system from storage tank to aquarium tables, nothing but lead comes in contact with the sea water.

Thus far, most of the plastic pipe that we have experimented with has proved unsatisfactory for use with salt water. Some types seem to work fairly well after they have soaked out for a week or more, but the fact that they need soaking out is proof that, for some time, at least, they cannot be considered ideal. All trials with ordinary plastic garden hose have shown it also to be unsatisfactory. Some types we have tried quickly killed hardy marine animals after the pipe had been immersed in salt water for a week. We are now testing different plastics to determine if any are suitable for use in marine laboratories.

One-fourth inch hard-rubber outlet cocks, threaded with $\frac{3}{8}$-inch pipe thread, are best over the aquariums. These are easily installed. A nail set is driven into the lead pipe, the opening thus made being enlarged with a punch of the proper diameter for threading. This method builds a lip within the pipe which prevents the jet opening (Fig. 2) from plugging up with any bit of debris which may come in when the storage tank is filled.

(7) The better the system, the more growth, such as mussels, oysters, barnacles, etc., there will be within the lead distributing pipes. This cannot be killed with cold fresh water, because the animals close and remain so until sea water again comes in. Heat, however, will kill them quickly, especially if they are young. We connect a hose from the hot-water line in the laboratory to the outer end of each pipe over the aquariums and run water (90°C.) back through the pipe to the storage tank. This is done after draining the tank, so the hot fresh water drains to the outside. This flushing should be done at least once a month, preferably more frequently.

(8) When building the storage tank it is very important to be sure that its floor slopes from all sides to the combination drain and filling opening (Fig. 1).

A cement tank mopped inside with hot asphalt makes an excellent storage tank. The cement should be thoroughly dry before applying the asphalt, and after mopping it can be made to bond tighter to the cement by careful application of a blowtorch. Reinforcing should be kept well to the outside of the tank wall, for if sea water ever comes in contact with the reinforcing iron, rust will creep along it, necessitating a new tank.

Book Reviews

Geomorphology. (4th ed.) C. A. Cotton. New York: John Wiley, 1947. Pp. 505. (Illustrated.) $6.00.

This edition of Prof. Cotton's *Geomorphology* is essentially a reprint of the previous edition. A few minor changes in figures have been made.

For an elementary text the book is remarkably comprehensive, slighting practically no phase of geomorphology. Unfortunately, the author attempts to do two things in one book and does not quite succeed in either. The book is an attempt at a textbook on the geomorphology of New Zealand as well as, a general textbook in geomorphology. It is much more of the latter, but the illustrations are largely from New Zealand, and many landforms are specifically illustrated by reference to features in that country. This feature of the book will undoubtedly prevent it from being as widely used in this country as it merits. It is unfortunate that the illustrations could not have been given a more international flavor.

The book is a presentation of geomorphology from the Davisian viewpoint. Dr. Cotton follows Davis religiously in his terminology and concepts, especially in the development of the "normal cycle." A chapter presenting some of the ideas of Penck and others who do not subscribe to Davis' ideas would enhance its value as a textbook.

Allotment of space is rather well balanced. However, devotion of 11 pages out of 492 to a discussion of the work of groundwater seems hardly adequate. The treatment of glaciation, volcanicity, and the work of the ocean is, on the whole, superior to that of the average American text. As is customary in Dr. Cotton's books, *Geomorphology* exhibits clarity of expression and logical development of concepts.

WILLIAM D. THORNBURY

Indiana University, Bloomington

Kinetic theory of liquids. J. Frenkel. Oxford, Engl.: Clarendon Press, 1946. Pp. xi + 488. (Illustrated.) $13.00.

Although the fundamental principles are more or less settled, the quantitative development of the theory of the liquid state is still in an early stage. For this reason a book on the subject might seem premature. The circumstance that an understanding of the principles of the theory of the liquid state has thus far been restricted to a narrow circle of physicists and chemists and the fact that the presentation of a new theory, even in crude and incomplete form, may serve to attract the attention of other scientists and to accelerate its further development, led the author to undertake the task of writing this book.

The author has accomplished his task in a very competent manner. He has based his presentation on intuitively plausible models and has necessarily and wisely emphasized the physical aspects of the theory rather than its mathematical and logical aspects. He has drawn freely on the analogy between liquid structure and the structure of crystalline solids—an analogy which leads to the quasi-crystalline model according to which liquids, while lacking the long-range order of the crystal lattice, possess local structural order closely resembling that of crystals. The author makes extensive use of the theory of holes and of his own theory of heterophase fluctuations in his treatment of the equilibrium and nonequilibrium properties of liquid phases. He prefers, in general, the kinetic approach to that of the equilibrium theory of statistical mechanics, even in the treatment of equilibrium problems. He has in the main succeeded in his objective of constructing a coherent and physically satisfactory description of liquid structure and of phenomena occurring in the liquid state.

The book contains a critical and, in spite of some gaps, remarkably complete survey of recent literature in the field. The author's comments on current work are sometimes sharply critical and open to debate, but they are always stimulating. The book can be recommended strongly to all workers in the field of chemical physics.

JOHN G. KIRKWOOD

Cornell University, Ithaca, New York

Scientific Book Register

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HOGNESS, T. R., and JOHNSON, WARREN C. *Qualitative analysis and chemical equilibrium.* (3rd ed.) New York: Henry Holt, 1947. Pp. xv + 553. $3.20.

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